



DRAFT – Pre-Decisional – FOR DISCUSSION ONLY

## Memorandum

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**Date:** *April 10, 2014*

**Subject:** *Identification of Principal Threat Waste at the Portland Harbor Superfund Site*

This technical memorandum was developed in support of the Portland Harbor Feasibility Study (FS). This memorandum presents an approach for identifying Principal Threat Waste (PTW) at the Portland Harbor site consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and EPA guidance. Consistent with EPA guidance, the identification of principal and low level threat waste is a site-specific decision. This PTW memorandum has been developed specifically for the Portland Harbor site based on site-specific information and is not meant as a restatement or reanalysis of Agency policy. The primary purpose of this memo is the identification of PTW; further consideration of PTW will take place during the development and evaluation of remedial action alternatives in the Portland Harbor FS.

## Regulatory Basis

### Principal Threat Waste

The NCP establishes an expectation that treatment should be used to address the principal threats posed by a site whenever practicable and to use engineering controls, such as containment, for waste that poses a relatively low long-term threat or where treatment is impracticable.

## Regulatory Definitions

### *Principal Threat Material*

EPA's *Guide to Principal Threat and Low Level Threat Wastes* (USEPA 1991) explains considerations for categorizing waste for which treatment or containment (in the case of low level threat wastes) will generally be suitable. The PTW guidance defines PTW as "those source materials considered to be highly toxic or highly mobile that cannot generally be reliably contained or would provide a significant risk to human health or the environment should exposure occur." Low level wastes are defined "those source materials that generally can be contained and that would present only low risk in the event of release" and includes "source

materials that exhibit low toxicity, low mobility in the environment or are near health-based values.”

### ***Source Material***

Contaminated sediments should first be classified as source material in order to be PTW. The PTW guidance defines source materials as materials that contain hazardous substances and act as a vehicle for contaminant transport or an exposure source. As an example, sediments contaminated with persistent bioaccumulative toxins (PBTs) such as polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane (DDT) could be a source of contamination to fish and shellfish. Contaminated sediments could also migrate due to current or wave action. As a result, contaminated sediments should be considered source material and, in fact, are specified as such in the PTW guidance.

### ***Concentration Based Threshold***

The PTW guidance states that where toxicity and mobility of source material combine to pose a human health risk of  $10^{-3}$  or greater, generally treatment alternatives should be evaluated. As an example, a concentration-based threshold can be determined in the following fashion: based on a sediment Preliminary Remediation Goal (PRG) for total DDx of 7 micrograms per kilogram ( $\mu\text{g}/\text{kg}$ ;  $10^{-6}$  risk level, 142 grams per day, mixed diet, fillet only), a concentration-based sediment threshold of 7,000  $\mu\text{g}/\text{kg}$  can be estimated for a  $10^{-3}$  risk level. In general, developing concentration-based thresholds based on a factor of 1,000 is appropriate due to the linearity of the calculations used to generate PRGs based on the results of the baseline risk assessments (i.e., multiplying the  $10^{-6}$  risk value by 1,000 will provide the  $10^{-3}$  risk value).

### ***Non-Aqueous Phase Liquids (NAPL)***

The PTW guidance specifically identifies NAPL floating on groundwater, pooled under groundwater, or located in fractured bedrock as PTW. The proposed plan for the Lower Duwamish Waterway (LDW) implements such guidance. The LDW plan notes that PTW is defined in EPA guidance as source material that is highly toxic or highly mobile, such as pools of NAPL, and that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.

## **Recommended Approach**

### **Principal Threat Waste**

The identification of PTW should focus on the primary contaminants of concern (COCs) developed in the FS for the Portland Harbor site. Based on the results of the risk assessment and other risk management considerations, the following chemicals have been identified as the primary or “focused” COCs for the site:

- Total PCBs
- Total polychlorinated dibenzo dioxins and furans as 2,3,7,8-tetrachlorinated dibenzo dioxin toxicity equivalents (Dioxin/Furan TEQ)

- Total 2,4' and 4,4'- dichlorodiphenyldichloroethane (DDD), dichlorodiphenyldichloroethylene (DDE), and DDT (Total DDx)
- Total carcinogenic polycyclic aromatic hydrocarbons (PAHs) as benzo(a)pyrene equivalents (BaPEq)
- Benthic toxicity

Because benthic toxicity was identified by a multiple lines of evidence approach, it is not considered well suited to the identification of PTW at the Portland Harbor site. As result, this evaluation only considers total PCBs, Dioxin/Furan TEQ, total DDx and BaPEq.

Although other COCs have been identified for the Portland Harbor site, it is expected that the evaluation of remedial action alternatives will be based on the primary COCs. **Table 1** presents PRGs and high concentration PTW thresholds for other COCs at the Portland Harbor site. If necessary to support the evaluation of remedial action alternatives, EPA will consider other COCs during the identification and evaluation of PTW. The other COCs will also be further considered during remedial design as necessary.

A multiple lines of evidence evaluation to determine the presence of PTW should incorporate the following criteria:

1. Direct observance of NAPL contamination in Portland Harbor sediments.
2. Indirect evidence of NAPL based on sediment contaminant concentrations greater than the corresponding theoretical solubility limits of the contaminant in porewater.
3. A high concentration threshold based on 1,000 times the lowest risk-based sediment PRGs established for the four primary COCs identified above.

It should be noted that source material only needs to meet one of these lines of evidence to be classified as PTW.

### **Observance of NAPL**

NAPL has been observed in contaminated sediments offshore of the Gasco facility. Figure 2.5.3-1 of the *Draft Engineering Evaluation/Cost Analysis (EE/CA), Gasco Sediments Cleanup Action* (Anchor QEA 2012) depicts sediment cores where “substantial product” was identified. Substantial product was identified based on visual observations and using the definition of substantial product described in the Gasco Sediments Site 2009 Administrative Settlement Agreement and Order on Consent (AOC), which is more expansive than just NAPL and includes solid tar layers.

Subsequent to the submittal of the Gasco EE/CA, the U.S. Army Corps of Engineers (USACE) presented their own evaluation of substantial product in the U.S. Moorings offshore area using

core data collected during the U.S. Moorings 2008 Remedial Investigation (RI) and 2008/2009 supplemental investigation. Based on this evaluation, USACE identified nine core locations they believed met the definition of substantial product as defined in the Gasco 2009 AOC SOW. In September and October of 2013, sediment cores were collected to confirm the results of the U.S. Moorings RI and supplemental investigation. Based on this work, it was determined that substantial product consistent with the AOC definition was limited to areas offshore of the Gasco site and was not present offshore of the U.S. Moorings site (USEPA 2014). The depiction of substantial product/NAPL offshore of the Gasco site is included as **Figure 1**.

It should be noted that while the definition of “substantial product” was developed specifically for the Gasco EE/CA, it is considered useful for identifying NAPL offshore of the Gasco site and identifying PTW for the purpose of evaluating remedial action alternatives in the Portland Harbor FS. The definition of substantial product includes not only NAPL but solid tar layers that may be present near the surface, and is therefore more expansive than simple observance of liquid NAPL.

CDM Smith also evaluated whether NAPL was present in sediment cores collected offshore of the Arkema facility (CDM Smith 2013). Sediment core logs were reviewed to determine whether visual observations of blebs, globules, dark brown oily material, or other terms indicating presence of product in a quantity greater than what could be characterized as sheen are present. Other lines of evidence evaluated included sheens and odors along with corresponding elevated organic vapor meter (OVM) readings, transition zone water (TZW) and offshore groundwater concentrations exceeding 1% solubility, and the documented presence of dense non-aqueous phase liquid (DNAPL) in upland soils. Lines of evidence were evaluated consistent with criteria presented in *DNAPL Site Evaluation* (Cohen & Mercer 1993). Based on this review, CDM Smith identified NAPL in 6 sediment borings located offshore of the Arkema facility based on the visual line of evidence as noted in the core logs. A figure summarizing the results of this evaluation is included as **Figure 2** of this memo.

### **Estimated Sediment Concentrations**

Sediment contaminant concentrations that would exceed the contaminant’s corresponding theoretical solubility limits in porewater based on pure phase solubility were estimated for key site contaminants. These contaminants include: benzo(a)pyrene, naphthalene, total DDT, total DDE, total DDD, chlorobenzene, trichloroethene and a range of PCB homolog groups. Saturated sediment concentrations (C<sub>sat</sub>) were estimated based on procedures outlined in a Technical Support Document developed by the Michigan Department of Environmental Quality (MDEQ 2007). C<sub>sat</sub> was estimated based on the following equation:

$$C_{sat} = \frac{S}{Kd + \frac{Kd}{\rho_b \theta}}$$

Where:

*C<sub>sat</sub>* = Soil saturation concentration

*S* = Chemical specific solubility

$\rho_b$  = Bulk density

*Kd* = Soil-water distribution coefficient where  $Kd = Koc \times foc$

*koc* = Chemical-specific organic carbon water partition coefficient

*foc* = Fraction of organic carbon in sediment

$\theta$  = Water filled porosity

The evaluation determined sediment concentrations exceeding theoretical solubility limits in surface and/or subsurface sediment are present at the Portland Harbor site for benzo(a)pyrene, naphthalene, chlorobenzene and total DDT. In addition, the evaluation determined that areas of free product sediment contamination are generally limited to sediment contamination offshore of the Gasco and Arkema facilities with two exceptions. These exceptions are a surface sediment sample collected in the navigation channel downstream from the Gasco site and a subsurface sediment sample collected at Port of Portland Terminal 4. These results provide supporting evidence of the presence of NAPL offshore of the Gasco and Arkema facilities. A summary of this evaluation is presented in **Table 2. Attachment A** provides backup information for the *C<sub>sat</sub>* values provided in **Table 2**, and includes the equations, sample calculations, values used in the calculations, and sources used to obtain the input values to calculate the sediment saturation concentrations.

### High Concentration Threshold

Areas with sediment contamination exceeding the 10<sup>-3</sup> risk level may be identified by multiplying risk-based sediment PRGs (i.e., 10<sup>-6</sup> values) by 1,000. At the Portland Harbor site, the exposure pathway for total PCBs, dioxin/furan TEQ and total DDx that presents the greatest risk is the fish consumption pathway. Although the fish consumption pathway also poses the greatest risk for BaPEq, due to the non-linearity of the sediment-tissue relationship, the risk-based sediment concentration associated with a 10<sup>-3</sup> risk level is lower for the direct contact exposure pathway. As a result, the direct contact exposure pathway was used to develop the high concentration threshold for BaPEq. High concentration PTW thresholds for the four primary COCs are presented in **Table 1** and depicted in **Figures 3** through **6**. This evaluation focused on surface sediments as contaminants in this interval pose the greatest risk of exposure to receptors. However, it should be recognized that additional areas of subsurface sediments with concentrations exceeding the high concentration threshold are present at the Portland Harbor site as outlined below:

- BaPEq: Offshore of Gasco and Terminal 4
- Total DDx: Offshore of Arkema including areas downstream of the Arkema docks

- Dioxin/Furan TEQ: Isolated occurrences offshore of River Mile 11 East (RM 11E), within the upper end of Swan Island Lagoon, and offshore of Linnton Plywood
- Total PCBs: Widespread occurrences throughout the Portland Harbor site

Evaluation of subsurface sediment contamination above the high concentration threshold will be incorporated into the detailed evaluation of remedial action alternatives.

## Summary and Conclusions

PTW is present in sediments at the Portland Harbor site based on multiple lines of evidence (note that only one line of evidence is needed to classify material as PTW):

- PTW is present offshore of the Gasco and Arkema sites based on direct observation of NAPL in Willamette River sediments (**Figures 1 and 2**). In addition, sediment concentrations offshore of these facilities exceed the theoretical saturated sediment thresholds, which provide indirect evidence that NAPL may be present (**Table 2**). Finally, the high concentration thresholds for total DDX, dioxin/furan TEQ, and BaPEq are exceeded (**Figures 3, 4 and 5**).
- PTW is present within the navigation channel downstream of the Gasco site and at Terminal 4 as evidenced by high concentrations of PAHs in surface sediment offshore of Gasco (**Figure 3**) and PAH concentrations at Terminal 4 that exceed the theoretical saturated sediment threshold (**Table 2**).
- Areas of PTW based on elevated levels of dioxin/furan TEQ are present offshore of the Arkema and McCormick and Baxter sites and within Willamette Cove and Swan Island Lagoon (**Figure 5**).
- Widespread occurrences of PTW based on elevated levels of PCBs in sediments above the high concentration threshold are present throughout the Portland Harbor site (**Figure 6**).

The FS should consider the presence, distribution and extent of PTW at these locations during the development and evaluation of remedial action alternatives at the Portland Harbor site. A key consideration during the evaluation of PTW is an assessment of contaminant mobility as it relates to removal and containment based alternatives. Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (USEPA 2005) provides guidance on the evaluation of PTW at contaminated sediment sites. The guidance notes that the practicability of treatment, and whether a treatment alternative should be selected, should be evaluated against the NCP's nine remedy selection criteria. The guidance also notes that in-situ containment can also be effective for principal threat wastes, where that approach represents the best balance of the NCP nine remedy selection criteria.

## References

Anchor QEA. 2012. *Draft Environmental Engineering/Cost Analysis, Gasco Sediments Cleanup Action*. Prepared for U.S. Environmental Protection Agency, Region 10 on behalf of NW Natural. May 2012.

CDM Smith. 2012. *Memorandum re: Gasco – U.S. Moorings Area Substantial Product Evaluation*. Prepared for U.S. Environmental Protection Agency, Region 10. October 26, 2012.

CDM Smith. 2013. *Memorandum re: Arkema Offshore NAPL Evaluation*. Prepared for U.S. Environmental Protection Agency, Region 10. June 25, 2013.

Cohen, R.M., and J.W. Mercer. 1993. *DNAPL Site Evaluation*. C.K. Smoley and CRC Press, Boca Raton, Florida.

Michigan DEQ, 2007. *RRD Operational Memorandum No. 1, Technical Support Document – Attachment 8*. May 2007 with June 27, 2007 correction.

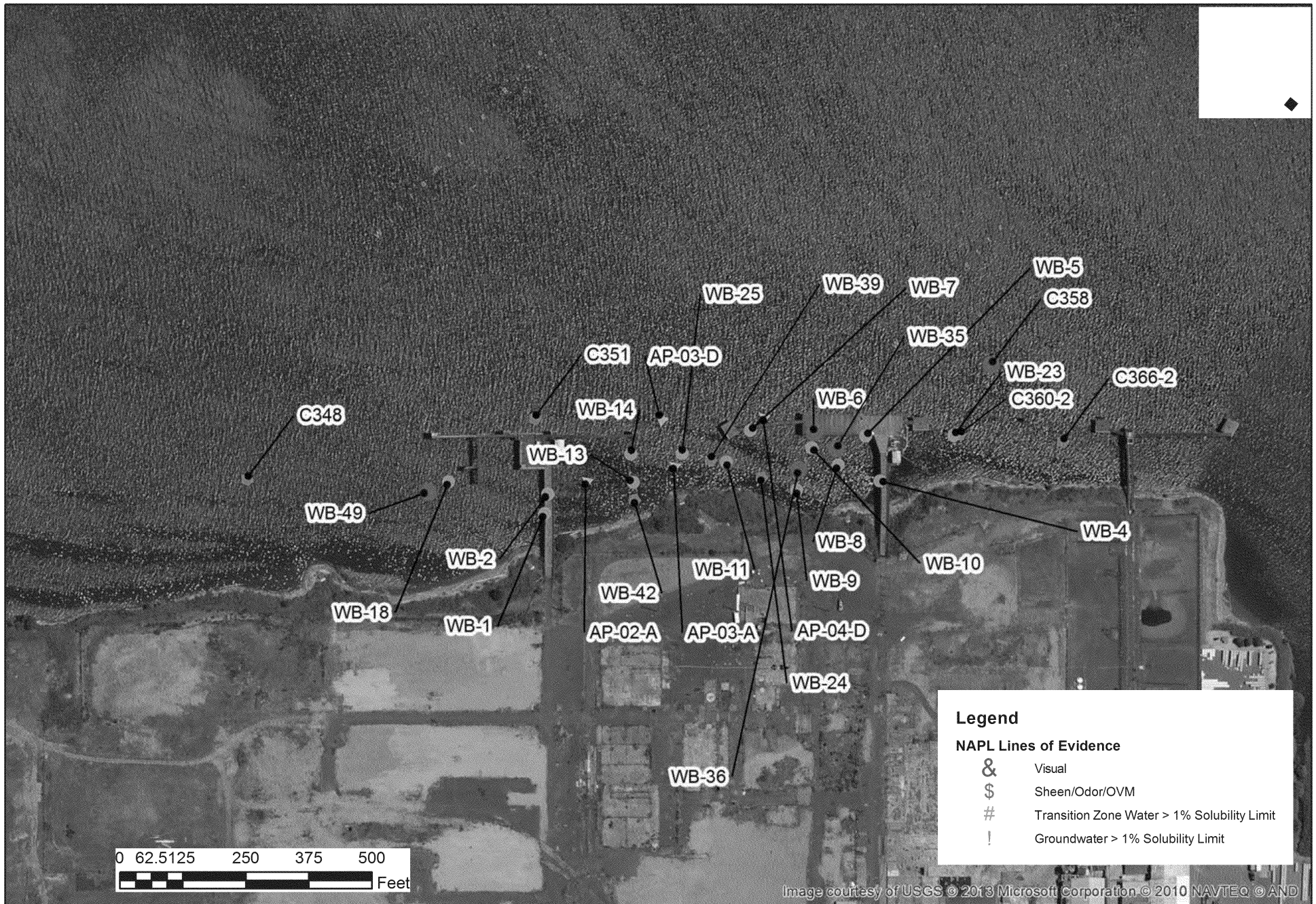
U.S. Environmental Protection Agency (USEPA). 1991. *Guide to Principal Threat and Low Level Threat Wastes*. Superfund Publication 9380.3-06FS. November 1991.

U.S. Environmental Protection Agency (USEPA). 2014. Letter from Sean Sheldrake to Bob Wyatt regarding Review of Data Report for EPA-required NW Natural Sediment Characterization Adjacent to U.S. Moorings Site - Addendum 1 to the Project Area Identification Report Quality Assurance Project Plan, GASCO site. January 21, 2014.

# Figures



**Figure 2: Non-Aqueous Phase Liquid (NAPL) Evaluation  
Arkema Inc.  
Portland, Oregon**





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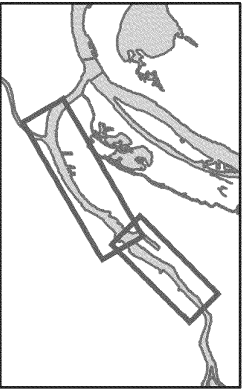
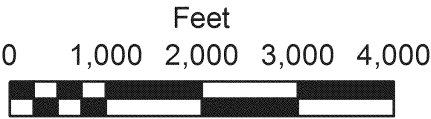
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Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGI, swisstopo, and the GIS User Community

**Legend**

-  SDU
-  > High Concentration PTW Threshold (7,000 ug/kg)



**Total DDx**  
**High Concentration PTW Threshold Exceedance**  
Threshold = 7,000 ug/kg

Figure 4

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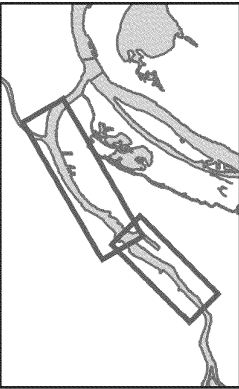
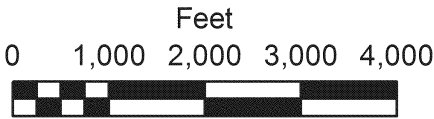
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AE



Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, ICI, swisstopo, and the GIS User Community

**Legend**

-  SDU
-  > High Concentration PTW Threshold (30 ng/kg)



**Dioxan Furan TEQ**  
**High Concentration PTW Threshold Exceedance**  
Threshold = 30 ng/kg

Figure 5

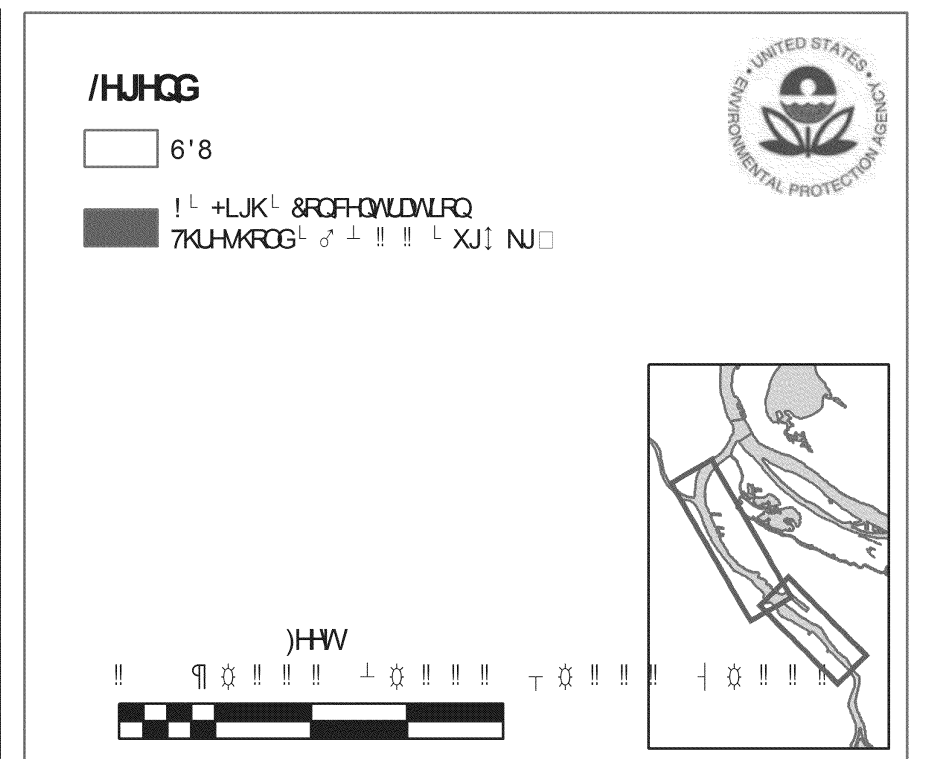


Figure 6

# Tables

**Table 1 – High Concentration PTW Threshold**

Portland Harbor Superfund Site

Portland, Oregon

Chemical	PRG Basis	Risk Based Sediment PRG	High Concentration PTW Threshold
<b>Portland Harbor Primary COCs</b>			
Total PCBs	Risk-Based (below background value)	0.2 µg/kg	200 µg/kg
Dioxin/Furan TEQ	Fish Consumption (mixed diet fillet only)	0.03 ng/kg	30 ng/kg
Total DDx	Fish Consumption (mixed diet fillet only)	7 µg/kg	7,000 µg/kg
BaPEq	Fish Consumption (mixed diet fillet only)	106 µg/kg	106,000 µg/kg
<b>Other Portland Harbor COCs</b>			
Aldrin	Fish Consumption (mixed diet fillet only)	0.6 µg/kg	600 µg/kg
Dieldrin	Fish Consumption (mixed diet fillet only)	0.1 µg/kg	100 µg/kg
Total Chlordanes	Fish Consumption (mixed diet fillet only)	1 µg/kg	1,000 µg/kg
Arsenic	Direct Contact - Human Health	3 mg/kg	3,000 mg/kg
Hexachlorobenzene	Fish Consumption (mixed diet fillet only)	1 µg/kg	1,000 µg/kg

Notes:

BaPEq – Benzo(a)pyrene equivalent

mg/kg - milligrams per kilogram

µg/kg – micrograms per kilogram

ng/kg – nanograms per kilogram

DDx – Sum of dichlorodiphenyltrichloroethane, dichlorodiphenyldichloroethane, and dichlorodiphenyldichloroethylene

PCB – Polychlorinated biphenyls

PRG – Preliminary Remediation Goal

PTW – Principal Threat Waste

TEQ – toxic equivalent

**Table 2 – Estimated Saturated Sediment Concentrations**

Portland Harbor Superfund Site

Portland, Oregon

Chemical	C(sat)	Notes
Benzo(a)pyrene	41 mg/kg	Widespread exceedances offshore of Gasco and Siltronic. Three exceedances in navigation channel downstream of the St. Johns Bridge. Numerous exceedances at Terminal 4, Slip 1 due to the presence of pencil pitch.
Naphthalene	1,200 mg/kg	Widespread exceedances offshore of Gasco and Siltronic.
Trichloroethene	3,100 mg/kg	No exceedances; maximum concentration offshore of Siltronic at 1,900 mg/kg.
Chlorobenzene	3,500 mg/kg	One exceedance offshore of Arkema between docks.
Total DDT (sum of 2,4 and 4,4'- DDT)	1,800 mg/kg	Numerous detections offshore of Arkema between docks.
Total DDD (sum of 2,4 and 4,4'- DDD)	1,600 mg/kg	No exceedances; maximum detection is 77 mg/kg offshore of Arkema.
Total DDE (sum of 2,4 and 4,4'- DDE)	1,400 mg/kg	No exceedances; maximum detection is 2.8 mg/kg offshore of Gunderson.
Trichlorobiphenyls	4,700 mg/kg	No exceedances; maximum detection is 12.7 mg/kg offshore of Gunderson.
Tetrachlorobiphenyls	3,700 mg/kg	No exceedances; maximum concentration is 14.2 mg/kg offshore of Gunderson.
Pentachlorobiphenyls	2,800 mg/kg	No exceedances; maximum concentration is 4.62 mg/kg offshore of Gunderson.
Hexachlorobiphenyls	5,400 mg/kg	No exceedances; maximum concentration is 2.99 mg/kg offshore of Gunderson.
Heptachlorobiphenyls	1,300 mg/kg	No exceedances; maximum concentration is 2.8 mg/kg offshore of Willamette Cove.

Note: Occurrences of sediment concentrations exceeding theoretical solubility limits are highlighted in Table 2.

mg/kg – milligrams per kilogram

DDT - dichlorodiphenyltrichloroethane

DDD – dichlorodiphenyldichloroethane

DDE – dichlorodiphenyldichloroethylene



# Attachment A

## Attachment A

### Equations, Sample Calculations, Values, and Sources Used to Calculate Soil Saturation Concentrations in Identification of Principal Waste at the Portland Harbor Superfund Site Memorandum, March 21, 2014.

Soil Saturation ( $C_{sat}$ ) Concentration Equation from Michigan DEQ, 2007:

$$C_{sat} = \frac{C_{org}}{K_{oc}} \left[ \left( \frac{f_{oc}}{f_{oc} + f_{inorg}} \right) + \left( \frac{f_{inorg}}{f_{oc} + f_{inorg}} \right) \right] \quad [X.1]$$

$C_{sat}$  Equation Assuming  $\theta_a$  Equals Zero from PTW Memo:

$$C_{sat} = \frac{C_{org}}{K_{oc}} \left[ \left( \frac{f_{oc}}{f_{oc} + f_{inorg}} \right) + \left( \frac{f_{inorg}}{f_{oc} + f_{inorg}} \right) \right] \quad [X.2]$$

Example Calculation Using Naphthalene Values from Table XX:

$$C_{sat} = \frac{31.7}{0.7} [(35.9 \times 0.7) + 0.7] = 1170 \text{ mg/kg} \quad [X.3]$$

Table A.1.

		Naphthalene	Benzo(a)Pyrene	4,4-DDT	4,4-DDD	4,4-DDE	Chlorobenzene	TCE	Trichlorobiphenylhomologs	Tetrachlorobiphenylhomologs	Pentachlorobiphenylhomologs	Hexachlorobiphenylhomologs	Heptachlorobiphenylhomologs
C <sub>sat</sub>	Soil Saturation Concentration (mg/kg)	1170.2	41.4023	1791.51	1620.09	13628.8	3480.18	3133.75	4658.5	3717.72	2824.38	5433.24	1263.01
S	Chemical-Specific Solubility in Water (mg/L)	31.7	0.0023	0.025	0.09	0.12	500	1070	0.65	0.26	0.099	0.038	0.014
ρ <sub>b</sub>	Dry Soil Bulk Density	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
K <sub>d</sub>	Soil Water Distribution Coefficient	3.59E+01	1.80E+04	7.17E+04	1.80E+04	1.14E+05	5.96E+00	1.93E+00	7.17E+03	1.43E+04	2.85E+04	1.43E+05	9.02E+04
Log K <sub>oc</sub>	Base 10 Log of K <sub>oc</sub>	3.3	6	6.6	6	6.8	2.52	2.03	5.6	5.9	6.2	6.9	6.7
K <sub>oc</sub>	Soil Organic Carbon Water Partition Coefficient	2.00E+03	1.00E+06	3.98E+06	1.00E+06	6.31E+06	3.31E+02	1.07E+02	3.98E+05	7.94E+05	1.58E+06	7.94E+06	5.01E+06
f <sub>oc</sub>	Fraction Organic Carbon in Soil	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
θ <sub>w</sub>	Soil Water-Filled Porosity	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
H'	Dimensionless Chemical Specific Constant	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TAF	Temperature Adjustment Factor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
θ <sub>a</sub>	Soil Air-Filled Porosity	0	0	0	0	0	0	0	0	0	0	0	0
C stat Concentration used in PTW Memo													
Integral et al, 2011. Draft Portland Harbor Report, Table 5.1-1; average TOC in surface sediments													
Anchor QEA et al, 2012, Draft Portland Harbor FS Report, Appendix Ha; bulk density and porosity for cohesive													
ASTDR Toxicological Profiles (Various)													
USEPA, 2013 Region 4 Technical Services Section Issue Paper for PCB Characterization													
K <sub>d</sub> =K <sub>oc</sub> ×f <sub>oc</sub>													
10 <sup>^(Log K<sub>oc</sub>)</sup>													
NA - Not Applicable													
Assume No Air-Filled Porosity													